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Jutta Gutberlet

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# Sustainability: a new paradigm for industrial production

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for industrial  
production

Jutta Gutberlet

*School of Geosciences, The University of Newcastle,  
Callaghan, Australia*

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**Keywords** Sustainable development, Industry, Production, Environment

**Abstract** Briefly discusses the industrial development process in Brazil by highlighting a few examples of its social and environmental implications. The current environmental crisis for which the industrial sector is co-responsible puts evidence on the existing links between production and consumption cycles. In order to identify impacts at their origin, production processes and products need to be re-assessed. Proposes a paradigm shift with the corporate world internalising the sustainability concept based on dematerialisation (tendency to use less material and energy inputs per unit of output) and eco-efficiency (strategy to provide goods and services while continuously reducing ecological impacts).

## Production and consumption: two faces of the same problem

Industrial production has contributed to the improvement of our quality of life. For most of us it is difficult to imagine not having access to consumer goods ranging from electronics, textile, foodstuff and beverages to sophisticated transport and communication means. However, while consuming, we usually do not recognise the environmental costs involved because they are externalised. The public and particularly already disadvantaged sectors of society have to bear the consequences from pollution and the loss of biodiversity, natural landscapes and cultural heritage. Manufacturing still depends mainly on the extraction of natural resources and much less on the use of recycled materials. It relies on the availability of energy and water and often requires space, the atmosphere, rivers and seas to absorb the out-coming waste.

Industrial activities, particularly in the mining sector, have profoundly transformed the landscape, often with cumulative and irreversible negative environmental consequences. Large corporations are involved in resource extraction and transformation in developing countries. Numerous examples put evidence on the fact that these companies usually do not take the necessary care to prevent environmental damage, nor to minimise negative impacts. The irresponsible practices are still in use, especially in countries with lax enforcement of the environmental legislation, with ridiculously low fines for environmental crimes and with a poor level of environmental public awareness (for examples see: Hall, 1991; Kennedy, 1996; Reborati, 1999).

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Environmental impacts due to production are not new phenomena. Ever since humans have settled, expanded in numbers and developed their culture (agriculture, architecture, manufacture, politics and religion) natural resources have been extracted and transformed, often with negative environmental trade-offs. However, the extension and current speed with which resources are extracted and the environment is contaminated and destroyed are unprecedented. The prevailing development model is not concerned with global sustainability as a fundamental characteristic to aspire, for present and future generations. A critical evaluation of the outcomes and the necessary costs to keep this model running would probably come to the conclusion that the concept is perverse and irrational.

The present paper analyses some of the major impasses resulting from destructive, inefficient and ultimately unsustainable industrial production and it discusses ways to change this situation. The paper further introduces a few local examples to discuss the topic within the Brazilian and Latin American context. Corporate crimes committed against human health and against the environment are often not recognised nor are the responsible held accountable for their actions. There are numerous examples, such as the accidents involving Union Carbide in Bhopal (India) and Cubatão (Brazil), the Exxon Valdez disaster, health damage through the selling of dangerous or defective products, and the exposure to emissions and toxic substances at the workplace. The factor time can also be a crucial one in terms of aggravating the dimension of environmental impacts. Cumulative environmental impacts are not recognised as such because each individual event by itself often does not have a perceivable impact, however, the cumulative effects over time can be critical and disruptive for the local ecology and human health (Hawken, 1993, pp. 116-22).

The scope of the problem requires a paradigm shift. In this paper the concepts of sustainability and clean production are discussed with special focus on the problems encountered in Brazil. Ecological footprint analysis (Wackernagel and Rees, 1995) and life cycle analysis (Clark *et al.*, 1993) are some of the possible approaches, which will be highlighted to assess environmental and social impacts.

Production does not exist without consumption, hence consumers are also responsible for the negative drawbacks from their adopted lifestyle. Environmental education is a medium to long-term measure that can help to change consumption and lifestyles towards the preference of products that are less resource and more labour-intense. This way environmental damage could be prevented in first place and expensive costs related to clean-ups and rehabilitation measures could be economised. Production that creates high levels of employment under fair conditions also contributes to a better distribution of wealth.

#### *Industrial development and the environment*

Brazil is the fifth largest country in the world in terms of landmass (8,512,000km<sup>2</sup>). It has a total population of 157 million inhabitants, of which

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58 per cent live in the South and Southeast (FIBGE Census Data, 1996). More than 80 per cent of the population lives in cities, which reflects a similar urbanisation rate to most Western European countries and North America (Potter and Lloyd-Evans 1998, p. 19). Between 1980 and 1991 the annual population increase was 1.94 per cent. If the population continues to grow at the same rate, it will double in approximately 30 years. This has important implications in terms of production and consumption.

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The early industrialisation in Brazil was based on the expansion of the primary sector and the export of raw materials. This period lasted until the 1930s when the Government initiated a development shift towards import substitution and began to build up an independent national industry. Since the mid 1940s Trans-National Corporations (TNCs) and large state owned firms started to operate and dominate the industrial development and the country's economy. Under the military dictatorship installed in 1964, large-scale development projects were implemented to promote economic growth (Sampaio Jr, 1999, p. 189). These different periods of industrial growth have originated a strong and diversified industrial sector, with a noticeable trend towards manufacturing industries. The country has become less dependent on the export of primary products and resources and has increased its exports of manufactured goods. In 1970, 87 per cent of the total merchandise exports were still primary products, whereas in 1994 the proportion had decreased to 45 per cent (Murray, 1999, p. 133).

Particularly during the early industrial development phase pollution and resource-intense industries benefited from the growth-oriented development model. At that time neither industry nor local governments paid much attention to environmental standards. The major aim was to attract foreign investment in order to obtain industrial growth. TNCs were given permission to establish new factories in Brazil as in other developing economies that were not equipped with the latest environmental technology. Hesselberg notes a double standard in environmental management practices adopted by TNCs in the South and the firms in the North (Hesselberg, 1992, p. 172). The environmental protection agencies in the most industrialised region in Brazil (São Paulo, Minas Gerais and Rio de Janeiro) were unable or unwilling to prevent this situation.

The limits to growth-oriented industrialisation were obvious decades ago, when socio-economic inequities and environmental impacts became evident. However, governmental policies still continued to stimulate investment in industrial production regardless of the possible scope of resulting environmental trade-offs. During the 1990s, some advances have been made towards cleaner production, often by way of the installation of new technologies or end-of-pipe solutions. Nevertheless, many of the old problems still remain. Often more sound developments are prevented in view of the actual and expected benefits from the global economic market and from elevated consumption levels.

*Environmental drawbacks of production*

Environmental impacts are often considered necessary side effects of development or the price to pay in order to achieve progress (Furley, 1996; Hesselberg, 1992; Weissman, 1993). The atmosphere, watercourses, oceans and holes in the ground – left open from previous mining activities – are treated as natural recipients for the waste resulting from extraction, transportation, production and consumption. However, industries are certainly not the only factors that put pressure on the environment. Agriculture, mining, forestry, fisheries, transport, housing, leisure and tourism also leave their footprints on the environment. Among the most severe impacts directly and indirectly related to production in general are:

- unrestricted exploitation of non-renewable natural resources such as minerals and petroleum;
- over-exploitation of renewable resources (e.g. through monocultural production systems in agriculture and forestry, overfishing and overuse of freshwater resources in industry and agriculture);
- contamination of soil, water and air due to production processes, generation of waste and inadequate final destination of used products;
- reduction of biodiversity due to deforestation, erosion, and soil impermeabilisation;
- climate change in response to the emission of greenhouse gases and damage to the ozone layer.

*Air pollution and industrial production.* Although the headlines concerning environmental impacts in Brazil are overshadowed by issues related to deforestation and land degradation; industrial pollution continues to be a severe problem. Industrial production is still on the rise, with many new manufacturing plants being set up and existing ones being expanded (automobile sector, agro-industries, food, beverages and chemical/pharmaceutical sector).

In the early 1980s air pollution became more prominent within the debate on environmental impacts in Brazil. Extensive “die-back” of the native forest due to air pollution from the industrial centre Cubatão, located at the foothills of the Serra do Mar mountain range and the emerging health effects brought the issue on top of the agenda. Land and mudslides presented a severe risk to the production plants and to the population living in close symbiosis with the industries. The peak of the environmental scandal was reached with the appearance of malformations in new-borns and high rates of blood cancer, skin and respiratory diseases in the local and the working population. In 1984, Cubatão was known not only as the worst pollution disaster in Brazil, but also for its exploitative working conditions and unhealthy and sub-human living conditions (Gutberlet, 1996).

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Cubatão also became a symbol for non-governmental activism on environmental and social justice, particularly after the disastrous fire due to a leaking oil pipeline in the squatter settlement Vila Socó and due to the struggle for better living conditions in Vila Parisi.

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During past years industrial pollution has also increasingly become a problem in peripheral regions such as the Midwest or the Amazon. Agro-industries and industries related to the extraction of native wood have already taken over most of the savannah region in the Midwest. In the Amazon region mineral extraction and the transformation of the minerals in smelters, deforestation and production of charcoal, as well as small-scale industries are the major pollution threats in the region.

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Today pollution problems are tackled with stricter environmental controls and by means of implementing more efficient production processes. These measures are not always successful due to lack of political will and generally weak enforcement of environmental standards. Reduction of production costs and maximisation of profits are still the guiding principles during the process of greening business. Almost 20 years after the pollution scandal in Cubatão the situation still remains unsatisfactory with elevated levels of toxic emissions and countless contaminated sites.

*The contamination of freshwater.* Latin America and the Caribbean are the most affluent regions in terms of annual internal renewable water resources. The region contains 23,900m<sup>3</sup> of water resources per capita, in comparison with East Asia and the Pacific (5,300m<sup>3</sup>/per capita), Canada and the USA (19,400m<sup>3</sup>/per capita) or with the world average (7,700m<sup>3</sup>/per capita) (IBRD, 1992 in Huby, 1998, p. 22). Further, within the region, Brazil is the country with the greatest general abundance in freshwater resources. Nevertheless, there are certain regions and cities – other than the traditional dry Northeast – that are already facing severe water shortages. Most of the large urban agglomerations already have to rationalise the distribution of drinking water during some periods of the year. Local governments often lack effective measures to protect water quality or to avoid the waste of water. Public policies may further underline unequal access to water; as industry, e.g. does not pay for the water extracted from rivers or wells and receives subsidies for piped water.

In the early 1990s water contamination became the most urgent environmental issue, receiving increasing attention by government agencies and by the production sector. The main rivers in the metropolitan region of São Paulo (MRSP), Tietê, Pinheiros and their tributaries receive most of the untreated sewage and industrial wastewater. Until recently, it was not even recognised as irresponsible or criminal to extract clean water from the river and to then deliver it in a polluted state, after having used it in production processes. The new catchments protection legislation for the state of São Paulo has introduced innovative instruments and regulations for land and water use, proposing an integrated planning, implementation and enforcement approach (Governo do Estado de São Paulo, 1997). In several regions throughout Brazil catchments committees and agencies have been installed to enhance more

efficient resource uses in the area. Furthermore, the recent change to the federal legislation on environmental crimes has opened new channels to prosecute environmental destruction, exploitation and contamination as crimes (Ministerio do Meio Ambiente, dos Recursos Hídricos e da Amazônia Legal, 1998).

Most industrial production processes depend on clean water. Hence industries should also have a vested interest in the conservation of water resources. Nevertheless, the prevailing principle among business is still to deliver water of lower quality. In São Paulo, the Tietê River Project has failed to improve the water quality of this river system. It has put some pressure on large industries to control and treat their effluents, yet the numerous small manufacturing plants remain the most challenging emission sources in the MRSP, which is a common problem also in other regions in Brazil. Together with domestic sewage, stormwater and garbage these diffuse emission sources add to local and regional water pollution. Small industries usually do not have the necessary funds to become properly equipped with technology to reduce emissions or to restructure their production processes. For being small and numerous these firms are often excluded from the public pressure to become cleaner. Small-scale industries usually do not have the funds to upgrade their processes. They have to rely on government financial support or other low-interest funding schemes to improve their environmental performance.

*Waste generation and management.* Waste generation has grown into a critical environmental impact. Soil contamination and irregular disposal of toxic waste are common problems in many urban-industrial agglomerations. There is also the imminent problem of the depletion of valuable land as industrial waste tips. Industries still produce large amounts of residues, which are sold, incinerated or deposited on their own premises and on specific public disposal areas. There is also the possibility of the waste being dumped illegally or transported out of the region. Severe environmental impacts are related to the toxic leachate and the contamination of the soil and underground water from irregularly dumped waste. Often local governments and the industry prefer to fix the problem by burning the waste. The incineration of residues does not solve the problem, it rather creates new ones. It burns valuable resources and it produces toxic emissions, which can be reduced only to a certain extent through filtering. It also produces ashes that require adequate treatment, which involves extra costs.

Many local governments are facing the same dilemma of finding areas for new dumping grounds or locations to set up incinerators. Public awareness has increased during the past few years and the NIMBY (not in my backyard) argument has also grown in Brazil, with NGOs and community groups opposing the installation of new incinerators. Nevertheless, the most obvious strategy, which is to diminish the production of waste and to incentivate recycling and re-use, has not yet been implemented to the extent that it would be a solution to the problem. A valuable initiative from the business

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community, called CEMPRE (Compromisso Empresarial para Reciclagem) is gaining significant ground in promoting the recycling of waste and the introduction of closed resource loops in industrial production.

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*Resource availability and production-consumption cycles*

Today's consumption patterns add to the generation of waste, with the packaging industry being particularly energy intense. The impacts deriving from a massive increase in non-biodegradable packaging have escalated in the 1990s. Often a significant cause for urban floods (besides the sealing of space) and landslides is the accumulation of domestic waste in drainages, creeks and rivers, impeding and slowing down the flow-off. It is the unsustainable packaging of consumer goods that creates severe risks and damage to the people and the environment. The situation has become particularly disastrous in many low-income neighbourhoods, often with garbage invading public and private spaces.

Consumption patterns influence production and vice versa. Each citizen contributes to resource depletion and environmental contamination by choosing a certain lifestyle and supporting a particular consumption model. These can be more or less resource intense, according to each one's own ecological footprint.

Ecological footprint analysis has been introduced by Mathis Wackernagel and William Rees to estimate resource consumption and waste assimilation requirements according to a certain human population or the economy, expressed through a corresponding productive land area (1993). The concept has its merits particularly in rising environmental awareness by highlighting the links between consumption and environmental impacts.

Worldwide consumption rates have increased exponentially, during the past three decades. However, there is a large disparity between the rich and the poor countries. In Africa, South America and Asia consumption levels are significantly lower, compared to the USA, Australia and Europe. For example the worldwide total energy consumption has increased from 5,575 million tons of oil equivalent, in 1975, to 8,504 in 1995. Approximately, 66 per cent of that amount was consumed by the industrial countries. The world electricity consumption doubled from 6,286 billion kilowatt-hours, in 1980 to 12,875 billion kilowatt-hours in 1995. Again, the largest proportion (72 per cent) is being consumed by the industrial countries.

Nevertheless, in the South consumption rates are also increasing rapidly. If they were to grow to the present rates of the North, the stress on the natural resource reserves and on the absorption sinks would have already put an end to growth. There is strong concern that many of today's hazards related to extreme and unpredictable climate events are due to post-industrial anthropogenic interferences on the environment (Balling Jr, 2000). It is irresponsible of the North to continue as if there were no limits and it is short sighted of the South to embark on the same resource intense production-consumption cycle.



With the urban livelihood, a new lifestyle based on mass consumption becomes predominant. Even remote and peripheral societies are now becoming increasingly affected by rapid and profound cultural transformations. One of the consequences of this development is a change in consumption and lifestyle. The way we live and what we consume has changed in quality and character. Natural ingredients are substituted with artificial ones and food processing has become more industrialised. Packaging is intensified – particularly the use of plastics, aluminium and paper/cardboard – yet the recycling of these resources is still not the prevailing practice.

Negative environmental impacts from road, air, and water transport also ought to be analysed within the production-consumption framework. The most important ones are air pollution and the associated health impacts, the loss of landscape due to the expansion of road networks, and water pollution due to fluvial transport. All over, manufactured and agricultural products travel long distances before they reach the consumer. A striking example for long distance travel of food products in Brazil results from the centralised system of fruit and horticulture commercialisation through the central market CEASA in São Paulo. Products are transported from as far as the Amazon region or the southernmost states in the country – distances of over 3,000 kilometres – to São Paulo, before they often return for consumption to the region of origin.

The previous discussion about the complex production-consumption systems and the interrelated social and environmental aspects leads to a first paradigm shift. When assessing environmental impacts caused by industry, the ecological footprint of consumption and lifestyle should also be evaluated. One step towards a more equitable and a more sustainable society is to identify impacts, their source of origin and their distribution. A common strategy besides Footprint evaluations is to quantify and qualify impacts through life cycle analysis. This strategy allows an assessment of all impacts occurred during the process of a certain product, which means an evaluation from cradle to grave (Clark *et al.*, 1993).

Another paradigm shift focuses on the fact that industry is responsible for the negative impacts of production. Therefore, it is also up to the corporate world to contribute to the change towards a sustainable society. The central demand is clean production and clean products. It has been widely argued that pollution prevention pays and that business ultimately benefits from the implementation of a precautionary environmental management policy (Thorpe and Kruszewska, 1999). However, a much stronger commitment is required from industry, one that goes beyond short-term economic outcomes and that considers a long-term perspective. For this to happen an ethical change that affects our value system and alters behaviour and attitudes has to occur, where stakeholders are committed to put pressure on industry and the economy for these paradigm shifts to happen. The solution has to come not only from the governmental sphere and the consumers, but also from business and the manufacturing sector.

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*Routes towards clean and sustainable production*

Industrial ecology (Ehrenfeld, 1992; Jelewski *et al.*, 1992) is a notion that contests the unsustainable model of industrial development. It understands production as a complex system, where extraction and production factors are closely connected. Production processes within one industry and among different industries are of a symbiotic nature, however the advantages deriving from this new perception have not yet been explored. Usually the outputs from specific production processes (e.g. heat, waste, gases, sewage and effluents) are considered waste or pollution and they cause certain remediation costs. The potential resources for other production processes are not recognised. From the perspective of industrial ecology, production is a closed cycle with no “waste” production and no resource losses. The principle is also known as clean production, with zero air and water pollution and no soil contamination. It builds on strategies that continually improve the eco-efficiency of a production plant in order to diminish environmental impacts. Negative trade-offs are transformed into goods and no resources are wasted. It further stresses on the reduction of the use of non-renewable resources.

Clean production relies on new and often alternative technologies and on the restructuring of production processes; it is a revolutionary ethical concept. According to this notion success is not primarily profit-oriented but depends on the ecological footprint and the long-term sustainability of production/consumption. According to Robins and Kumar (1999) the implementation of eco-efficiency involves the following steps:

- Reducing material intensity of goods and services (increasing dematerialisation).
- Lowering energy input.
- Reducing the dispersion of toxic waste and by-products.
- Maximising sustainable use of renewable resources.
- Extending product durability.
- Increasing service intensity of goods and services.

The transition towards clean production focuses on a series of fundamental changes in the production process. A major transformation is expected from a general reduction of the resource flows, in regard to raw materials, water and energy. Second, clean production involves a change towards renewable energy sources and renewable raw materials. Finally, it involves a better product design that allows reuse and recycling and consequently reduces the speed of the production-consumption cycles.

Environmental education is changing the perception of stakeholders, who are demanding a more responsible and caring attitude from business (Robins and Kumar, 1999). Pressure groups can make a difference in urging industry to replace non-renewable with renewable materials and energy sources. They can persuade business to prefer local resource providers and they can influence

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them to innovate product design (towards products that have a long life, that are recyclable and biodegradable). All these measures will ultimately improve the quality of life of the local community.

The new paradigm for industrial production is in line with what is being discussed under industrial ecology. It is a systems-oriented approach away from the rather process-oriented view (e.g. end-of-pipe strategies). From this perspective, a business is reviewed in terms of its organisational and technical ability to improve processes, to produce more efficiently, to utilise waste and to co-operate with stakeholders and suppliers (Marstrander, 1996, p. 199). The concept is still evolving, but there are already some examples that describe how business can change towards zero emission and clean production (see Thorpe and Kruszewska, 1999 and references in Marstrander, 1996).

The basis for a transformation in production lies within a change of attitudes and values. It is probably the most difficult task to convince business that it is in its own long-term benefit to review production-consumption seriously focusing on sustainability. Industries can actually gain from the implementation of strategies that relate to clean production, that are small-scale, that are community oriented (respecting the local to global community), and that favour diversification (cultural heterogeneity and biodiversity) (see Schumacher, 1973). The change expected from business is not grounded solely in better technologies and more efficient processes, but rather in a mentality change among leading groups towards understanding, valuing and implementing clean production.

Environmental education is the key to this paradigm shift. Environmental awareness and education contribute, with the construction of a widespread knowledge and recognition of our limits, to growth. Increased awareness and care for the environment will put the necessary pressure on political and economic decision-makers. Informed and aware consumers prefer eco-efficient products to those which cause greater environmental and social impacts. Their consumption preference can make a difference in pushing other producers into the same direction, e.g. to improve their product design towards a greater integration of biodegradable or recyclable materials. Product labelling and qualification in terms of information on eco-efficiency is essential for the consumer to make the right choice. However, the information has to be clear, meaningful and not misleading.

Recent uprisings contesting the politics of the World Trade Organisation in Seattle and of the World Bank in New York are the first signals of the increased stakeholder awareness over sustainability and equity issues. Growth in environmental concerns among politicians, businesses, stakeholders and the local community is a basic requirement if the paradigm is shift to happen. The problem is not the lack of technical or strategic solutions to prevent further environmental destruction or the overexploitation of natural resources, but rather a lack of willingness from business to change the current situation. Companies that are ready to take the step towards sustainable and clean

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production will be on the leading edge. Industry can make a significant contribution to global and local sustainability and furthermore clean production can invert their negative image of the environmental villain.

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